OPTIMIZATION OF PRODUCT FUNCTION FOR HANDICAPPED PURPOSE USAGE

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SUPERVISOR'S DECLARATION

I hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering Pure.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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Dedicated to beloved parents, Mr. Abdull Talib b. Daud and Mdm. Juzlina bt. Hj. Jazam and my dearest, Ernie Herwina bt Hamzah for their everlasting love, guidance and support in the whole journey of my life.

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ABSTRACT

This thesis elaborates about methods done to optimize product function for handicapped purpose usage. The objectives of this project are to identify suitable general product for the usage of handicap people, redesign and analyze the product to optimize the usage for handicapped usage and to simulate and the design of the product. This thesis gathered information from previous research and study as a guideline to generate suitable concepts for flexible cooker. The concept undergoes several processes in order to determine the best suit concept for both handicap and normal user. Based from the process before, several sketches was sketched on the plain paper and transferred into three-dimensional using Computer-Aided Design tool which is SolidWork. The concept then was chosen using appropriate selection procedure. The concept selection method used is concept screening. After the concept was chosen, the design was analyzed using compatible Finite Element Analysis (FEA) software with different materials. The software used in the project is FEMPRO. Finally, the conclusion and recommendation was stated.

ABSTRAK

Tesis ini menghuraikan tentang kaedah yang dilakukan untuk mengoptimumkan fungsi produk untuk kegunaan orang kurang upaya. Objektif projek ini adalah untuk mengenalpasti produk umum yang sesuai untuk kegunaan orang-orang kurang upaya, menganalisa semula produk untuk mengoptimumkan fungsi untuk kegunaan orang kurang upaya dan untuk mensimulasikan dan menganalisis desain produk. Tesis ini mengumpul maklumat daripada kajian-kajian terdahulu sebagai panduan untuk menghasilkan konsep-konsep yang berpadanan untuk alat memasak fleksibel. Konsep mengalami beberapa proses untuk menentukan konsep yang paling sesuai bagi pengguna yang kurang upaya dan juga normal. Berdasarkan proses yang dijalankan sebelumnya, beberapa sketsa dilukis diatas kertas biasa dan dipindahkan ke dalam lukisan tiga-dimensi menggunakan alatan bantuan melukis iaitu SolidWork. Konsep kemudian dipilih menggunakan prosedur yang sesuai. Kaedah pemilihan yang digunakan adalah konsep penapisan. Setelah konsep dipilih, desain serasi dianalisis menggunakan perisian Finite Element Analysis (FEA) dengan menggunakan empat material yang berlainan. Perisian yang digunakan dalam projek ini adalah FEMPRO. Akhirnya, kesimpulan dan cadangan tersebut dinyatakan.

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LIST OF SYMBOLS

ι	Pitch Length
μ	Coefficient of Friction
θ	Angle
D_p	Pitch Diameter
F	Force
F_y	Force at y-Axis
M	Moment
T_l	Torque to Raise the Load
T_u	Torque to Lower the Load

LIST OF ABBREVIATIONS

AC	Alternate Current
ADL	Activities of Daily Living
AISI	American Iron and Steel Institute
AMPS	Assessment of Motor and Process Skills
ASTM	American Society for Testing Materials
CAD	Computer Aided Design
CAE	Computer Aided Engineering
DTI	Department of Trade and Industry
ECMT	European Conference of Ministers of Transport
FEA	Finite Element Analysis
FEM	Finite Element Method
FYP	Final Year Project
LLFDI	Late Life Function and Disability Instrument
OTA	Office of Technology Assessment
SCI	Spinal Cord Injury
SMWT	Six-Minute Walk Test
SPPB	Short Physical Performance Battery
UCP	United Cerebral Palsy Association of Michigan

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In this chapter, all important statement was verified such as project background, problem statement, project objectives, project scope and arrangement of report. Basic ideas about the project were determined in project background section to inform briefly about the project. In problem statement section, all problem that handicap faced, requirement and characteristic that needed to optimize product function for handicap purpose usage were stated. At the side of project background and problem statement, the determination of project objectives and project scopes were also stated.

1.2 PROJECT BACKGROUND

A handicap is any condition which result in the person being placed at a disadvantage in coping with and solving the problems of socialization, school, work and independent living. When a person is unable to cope or requires a great deal of extra assistance in coping with the demands of everyday living, then that person is disabled. Some examples of the most common types of disabilities are mobility and physical impairments, mental retardation, blindness, deafness, and cerebral palsy.

In Malaysia, the increment of the number of handicapped person registered with Social Welfare Department from year 2003 to 2005 was announced which from 132,655 persons in year 2003 to 170,455 persons in year 2005. The number of registered person with disability by type of disability was recorded and can be referred in Appendix A.

The subject of the study is mainly focus upon physical impairments which have been the subject of the studies. As a mechanical engineering student, physical impairments including dwarf can be referred as biomechanical relatively, therefore the problem in facing daily activities can be solves using mechanical solution approaches by taking flexible cooker as the product for both normal and handicap person.

1.3 PROBLEM STATEMENT

In Malaysia, the effort done to help handicap person by Malaysian Government still cannot fulfill the need of extra assistance in coping with the demands of everyday activities. Handicap people still need extra assistance because the effort done by Malaysian government only focusing to public needs such as handicapped toilet and footsteps and not to private need such as cooking tools and vacuum cleaner. Thus, the purpose of conducting the project is to help handicap person facing their daily activities by reproducing a product after optimizing its function and at the same time, the product also can be used by normal people.

Optimization of product function especially for handicap people must consider many elements. Firstly, the product must have safety element such as braking systems and blunt angles to avoid any kind of accident from the handicapped because they already facing many problem in daily life activities. Secondly, the products must user friendly because most of the problem that handicapped faced is to handling the product efficiently. Complicated product will spoil them. In addition, the product must also made by suitable material, based on the product purpose. Heavy product will cause problems especially in transporting. Lastly, the ergonomic element also must be applied in order to comfort both normal and handicap user.

1.4 OBJECTIVES

The project covers three objectives which are:

i. Identify suitable general consumer product for handicap person.
ii. Redesign and analyze critical part of the product to optimize the function of the product.
iii. Simulate and analyze the design of the product with different materials.

1.5 PROJECT SCOPES

The scopes of the project are:

i. Minimizing handicap people's needs of extra assistance in performing daily activities especially in cooking.
ii. Redesigning and adding up of several functions and being analyzed using compatible software to optimize product function.
iii. Suitable material selection based on the result of analysis.

1.6 ARRANGEMENT OF REPORT

In Chapter One, overall framework of basic information about this project such project background, problem statement, project objectives and project scopes were mentioned briefly to inform the reader about the project. Basic ideas about the project were determined in project background section to inform briefly about the project. In problem statement section, all problem that handicap faced, requirement and characteristic that needed to optimize product function for handicap purpose usage were stated. Besides project background and problem statement, the determination of project objectives and project scopes were also stated.

Next in chapter two represents a review of various theoretical topics which are related in this project. All important information and theoretical study were explained briefly and mentioned in this chapter as the project reference. Some of the explanations

can give extra information which useful while conducting similar project and can also use as reference for a further study that involving handicap person.

Chapter Three describes the methods used to completing this project. The methods include the process flow chart and gathering information data using several methods such as distributing questionnaire and data from previous study. Solid modeling, material selection and design concept and criteria also were discussed in this chapter.

The report followed by chapter four which consist of the result gathered from the questionnaire, the concept selection process and the analysis of the concepts. The analyses for the solid model were done using ALGOR within several selected materials. The material were chosen as to it availability in the market and at present of general machining in factory shop. All the results then discussed about the additional feature that can fit the concept and the alteration that can be made for the concept design.

Finally, chapter five will conclude the project and briefly enlightened about the recommendation that can be applied to the project. The conclusion were done according to the appropriate result obtain from previous analyses and important questionnaire. The project was in logical and scientifically manner believed to achieve its objectives. Hence, the recommendations in order to extend and critically improve the product function were stated for future project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents a review of various theoretical topics which are related in this project. All important information and theoretical study were explained briefly and mentioned in this chapter as the project reference. Some of the explanations can give extra information which useful while conducting similar project and can also use as reference for a further study that involving handicap person.

2.2 DEFINITION OF OPTIMIZATION OF PRODUCT FUNCTION

The word ‘optimization’ is taken from the verb ‘optimize’ which can be define to make the best or most effective use of some situations or resources, and in this project most of the focus is to optimize cooking tools for person who have physical impairment and at the same time, can be use by normal people. Optimization process must considered many elements including identifying customer needs, redesign and analysis of new design and ergonomic elements especially for the purpose of the product and the categories of user.

2.3 DEFINITION OF HANDICAP PEOPLE

A handicap is any condition which results in the person being placed at a disadvantage in coping with and solving the problems of socialization, school, work and independent living (Fotheringham). The term of handicap mostly used to refer to

individual functioning including physical impairment, sensory impairment, cognitive impairment, mental illness, deafness, blindness and various type of chronic disease.

Figure 2.1: International symbol of accessibility.

Source: *http://www.usa-traffic-signs.com/Handicap_s*

There are several types of disability including various physical and mental impairments which can minimize the ability of a person and requires a great deal of extra assistance in coping with the demands of everyday living activities.

Physical disability can be either an in-born or acquired with age problem. The effect of diseases such as diabetes and cancer also listed as the cause of disability. Besides that, people who had been involved in an accident and have broken bone also fall into this category of disability. Spinal cord injury (SCI) mostly occurs due to severe accidents. Sometimes, these types of injury can lead to lifelong disabilities. The injury can be either complete or incomplete. In an incomplete injury, the messages conveyed by the spinal cord not completely lost while a complete injury results a total dis-functioning of the sensory organs. Peoples that are completely or partially deaf are categorized in deafness. Deafness can be evident at birth or occur later in life from several biologic causes, for example meningitis can damage the auditory nerve or the cochlea. While scratched cornea, scratched on the sclera, diabetes related eye conditions, dry eyes and corneal graft are listed as common vision impairments.

2.4 PREVIOUS RESEARCH

Development of product for handicapped purpose usage has been taken as one of the requirement through the development of latest technologies. However, the problem faced by handicap peoples must be identified before the developing processes are proceeding in order to suit handicap people with the new product.

The research covers the problem and limitation faced by handicap people especially in managing daily life, the effectiveness of progress to improve accessibility and the anthropometry factor related to handicap people. The study is then tabulated in Table 2.1 for quick reviews. The source and the simple description are also mentioned in the table.

A study done by the DTI Consumer Affairs Directorate of Government Consumer Safety Research of United Kingdom has been concerned with promoting "safety in the design" of consumer products in order to reduce accidental injuries. The title of the study is 'A Study of the Difficulties Disabled People Have When Using Everyday Consumer Products'. So far the concern has been mainly with children, adults and the elderly population. This study aimed to identify the nature of the problems that disabled people have with consumer products and to determine what characteristics and capabilities should be measured. The Institute of Occupational Therapy uses two methods in their assessment of Activities of Daily Living (ADL). The first 'BARTEL' was not considered to be useful in aiding the project's investigation, on the advice of the Institute of Occupational Therapy, who recommended the second method 'the Assessment of Motor and Process Skills' (AMPS). Whilst this is basically a method of assessing ability in relation to ADL, it was felt that its basic principles and methodology could be used to access the difficulties that disabled people have with consumer products and to identify related functional issues. AMPS motor and process skill items that could be extrapolated to the product use were kept, while others, of less relevance to product use, were discarded. The motor skill items retained were manipulate, lift, grip, transport and reach. The process skill items retained were sequences, notices, uses, and terminates. The scoring scale was expanded from four point AMPS scoring scale to five point rating scales to reflect the needs of the survey as follow:

1 = competent

2 = adequate-with some difficulty

3 = adequate with much difficulty

4 = ineffective

5 = deficit

The interview and the assessment study highlighted a number of products that caused difficulty for disabled people including packaging household utensils, machine controls and large and heavy machine such as vacuum cleaners. The detailed analysis of the problem participants had with those task and products selected for assessment give clear indication of the nature and type of functional demands such products make on disabled people. As a result of this analysis the characteristics and capabilities of disabled people that need to be measured was identified.

Secondly, the purpose of the study on relationships among impairments in lower-extremity strength and power, functional limitations, and disability in older adults was to examine how impairments in lower-extremity strength and power are related to functional limitations and disability in community-dwelling older result. People well known that during the aging process, older adults may experience a loss of strength and power, which then may lead to functional limitations and disability. This study takes thirty older adults which are twenty-five women and five men with mild to moderate functional limitations as a subject of study. Lower-extremity strength, peak power, power at low relative intensity, and power at a high relative intensity were measured with pneumatic resistance leg press. Functional limitations and disability were assessed with the Short Physical Performance Battery (SPPB), the Six-Minute Walk Test (SMWT), and the Late Life Function and Disability Instrument (LLFDI). All measures of strength and power were related to functional limitations. Peak power demonstrated the strongest relationship with SMWT, the SPPB gait speed subscale, and the LLFDI functional limitation component. Power at a high relative intensity demonstrated the strongest relationships to the SPPB total score and the SPPB sit-to-stand subscale score. All measures of strength and power were indirectly related to the LLFDI disability component.

Technology exerts a powerful influence over the lives of everyone, making life easier, more fulfilling, but sometimes more painful and frustrating. This statement is especially true for people with disabilities. According to the study of 'Technology and Handicapped People', the appropriate application of technologies to diminishing the limitations and extending the capabilities of disabled and handicapped person is one of the prime social and economic goals of public policy. The Senate Committee on Labor and Human Resource of United State of America requested the Office of Technology Assessment (OTA) to conduct a study of technology for handicapped individuals. OTA and the requesting committee both recognized the extremely broad and complex range of issues that could be addressed in such study. Therefore, OTA conducted a planning study. Using the result of that study, OTA prepared a proposal for a full assessment on technology and handicapped people, which was approved by the Technology Assessment Board in September 1980. The study examined the specific factors that affect the research and development, evaluation, diffusion and marketing, delivery, use, and financing of technologies directly related to disabled people. The problems and processes of the development and use of technologies were analyzed in the context of societal allocation of resource and the setting of goals for public policy. The study concentrated on two critical matching processes: between technological needs and technological capabilities; and between allocation goals or intentions and resource capabilities. The objectives of the assessment and planning system are to provide data for determination of eligibility for services, determination of services required, and evaluation of the effectiveness of services provided.

This European Conference of Ministers of Transport (ECMT) publication titled 'Transport for People with Mobility Handicaps Policy and Achievements in Europe' has three main objectives. These are first, to bring the issues concerning accessible transport to the attention of a wide audience. Second objective is to describe the progress that is being made nationally and internationally to improve accessibility. Third, to set out principal challenges and problems that remains. People with mobility handicaps need to be able to reach their workplaces. This is an essential element of their professional and economic situation. Without accessible local transport, apparently simple activities such as medical or dental appointments, or household shopping, may have to be planned well in advance and assisted by other people. Social life and recreational activities are